MOBILE COMPUTING

CSE-4225

Course Goals

- Fundamentals of mobile computing
- Fundamentals of wireless networking
- Topics from closely related areas:
  - Pervasive Computing
  - Wearables
  - Internet of Things
  - Real-Time Systems
  - Embedded Systems
  - Wireless sensor networks
- Acquire and practice development skills

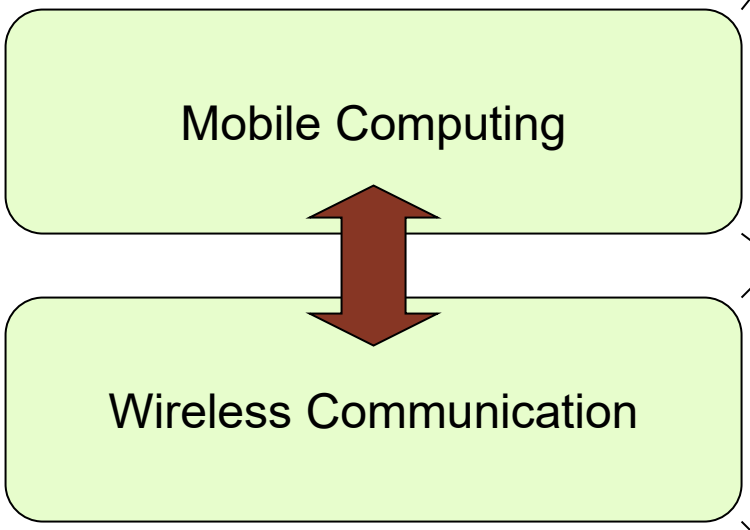
Mobile Computing (MC)

- Umbrella term used to describe technologies that enable people to access services **anytime** and **anywhere**

- Allows transmission of **data, voice and video** via a **computer or any other wireless enabled device** without having to be connected to a fixed physical link

- Main concept involves
  - Mobile Communication
  - Mobile Hardware
  - Mobile Software

Mobile Computing



- Applications
- Location-awareness
- Mobility Support
- Security
- Resource Management
- Network Protocols
- Broadcast
- Technologies
- Standards
- Wireless Medium

Wired vs Wireless

- **Wired Networks**
  - high bandwidth
  - low bandwidth variability
  - can listen on wire
  - high power machines
  - high resource machines
  - need physical access (security)
  - low delay
  - connected operation
- **Mobile Networks**
  - low bandwidth
  - high bandwidth variability
  - hidden terminal problem
  - low power machines
  - low resource machines
  - need proximity
  - higher delay
  - disconnected operation

Main Concept: Mobile Comm.

- Refers infrastructure to ensure seamless and reliable communication
- Protocols, services, bandwidth, and portals
- No collision with other existing systems (as well as same service)

Main Concept: Mobile H/W

- Includes mobile devices or device components that receive or access the service of mobility
- Capable of sensing and receiving signals
- Capable of sending and receiving signals at the same time
  - Which transmission mode?
- Example
  - portable laptops, smartphones, tablet PCs, Personal Digital Assistants

Main Concept: Mobile S/W

Mobile Computing: Aspects

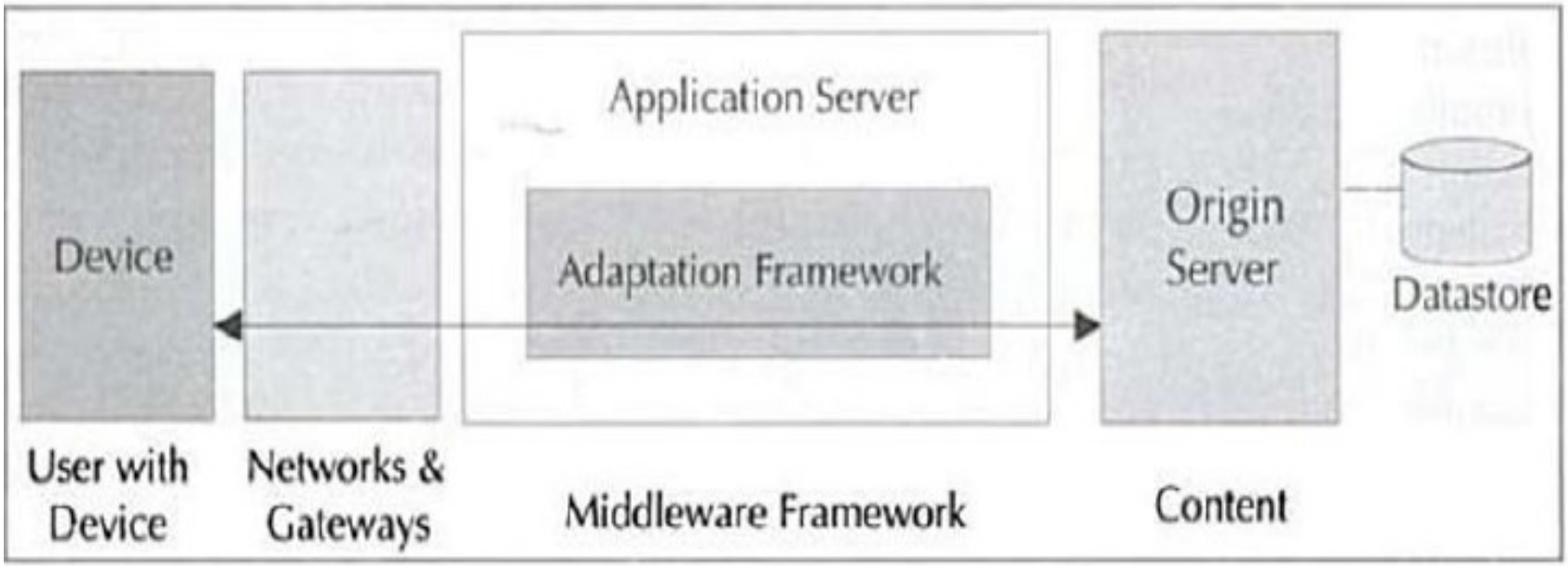
- **User Mobility**
  - Users communicate “anytime, anywhere, with anyone”
  - Example: read/write email on web browser
- **Device Portability**
  - Can be connected anytime, anywhere to the network (using different mechanisms)
- **Communication Device Characteristics**
  - Fixed and wired
  - Mobile and wired
  - Fixed and wireless
  - Mobile and wireless (most interesting)
    - Most successful: GSM with more than 800 million users

Mobile Computing: Functions

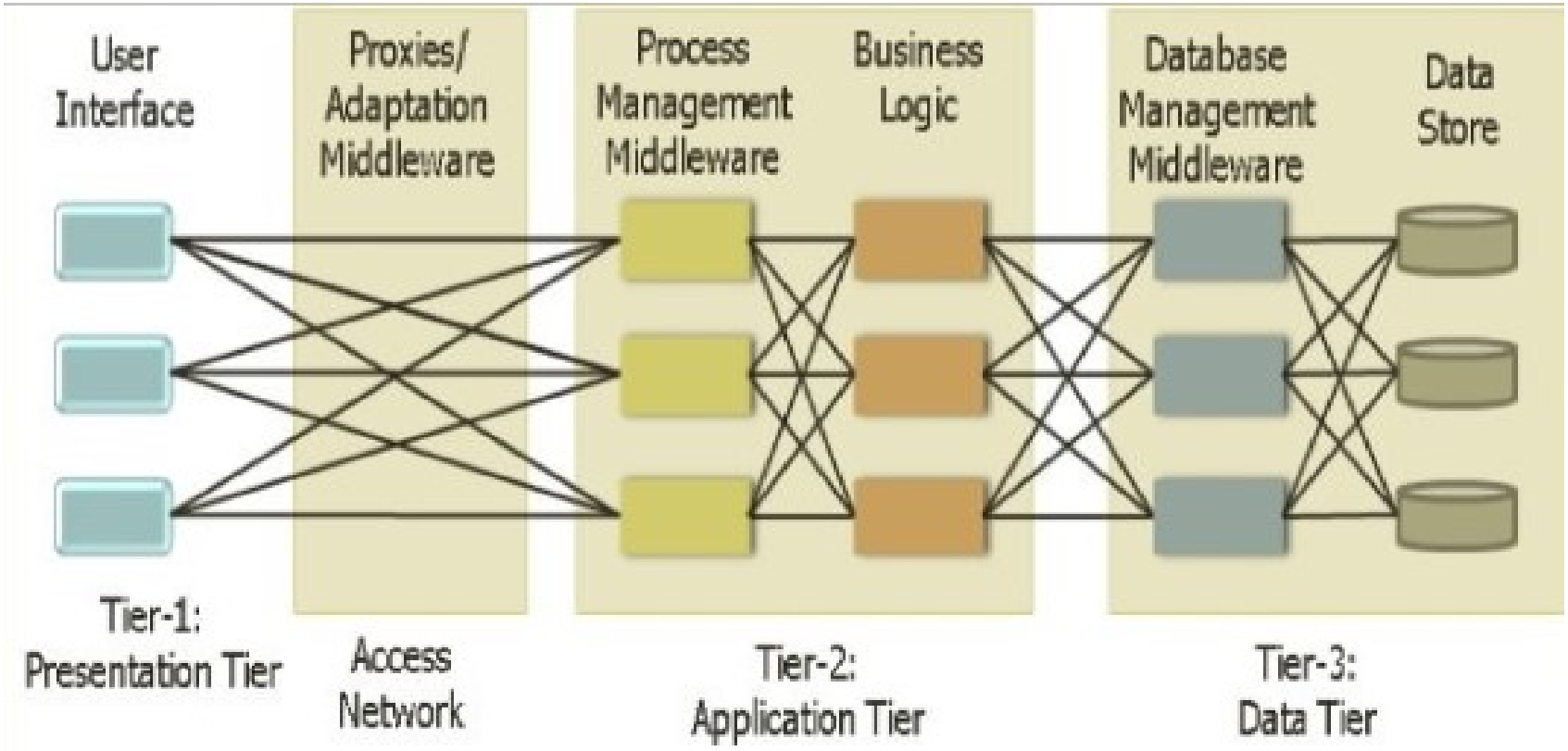
- **User Mobility**
- **Device Mobility**
- **Network Mobility**
  - Able to move from one network to another network (can be another country)
- **Bearer Mobility**
  - Allows a device to change bearers (WLAN, 3G, GPRS) without interruption to the user's data sessions
- **Session Mobility**
  - Able to move from one user-agent (acting on behalf of a user, such as a web browser) environment to another
- **Service Mobility**
  - Able to move from one service to another
- **Host Mobility**
  - Either a client or server

Logical Functions of MC

- **User with device**
- **Network**
- **Gateways**
- **Middleware**
- **Contents**



Mobile Computing: Architecture



Mobile Computing: Architecture

- **Presentation Layer (UI)**
  - Presents data to the user
  - Permits data manipulation and data entry
  - Requests the data form Business layer
  - Accomplished through use of Dynamic HTML and client-side data sources and data cursors

Mobile Computing: Architecture

- **Business Logic Layer**
  - Acts as the server for client requests from workstations according to Business rules fetch or insert data through the Data Layer
  - Determines what data is needed (and where it is located) and acts as a client in relation to a third tier of programming that might be located on a local or mainframe computer
  - As not tied to a specific client, it can be used by all applications and can be moved to different locations, as response time and other rules require

Mobile Computing: Architecture

- **Data Access Layer**
  - Made up of the DBMS that provides all the data for the above two layers.
  - Avoiding dependencies on the storage mechanisms
    - Allows for **updates or changes** without the application tier clients being affected by or even aware of the change

Mobile Computing: Applications

- **Vehicles**
- **Emergencies**
- **Business**
- **Credit Card Verification**
- **Infotainment**
  - Broadcast material that is intended both to entertain and to inform
- Where not?

Mobile Computing: Limitations

- Resource constraints: Battery
- Interference
- Bandwidth
- Dynamic changes in communication environment
- Network Issues
- Interoperability issues
  - varying protocol standards
- Security constraints

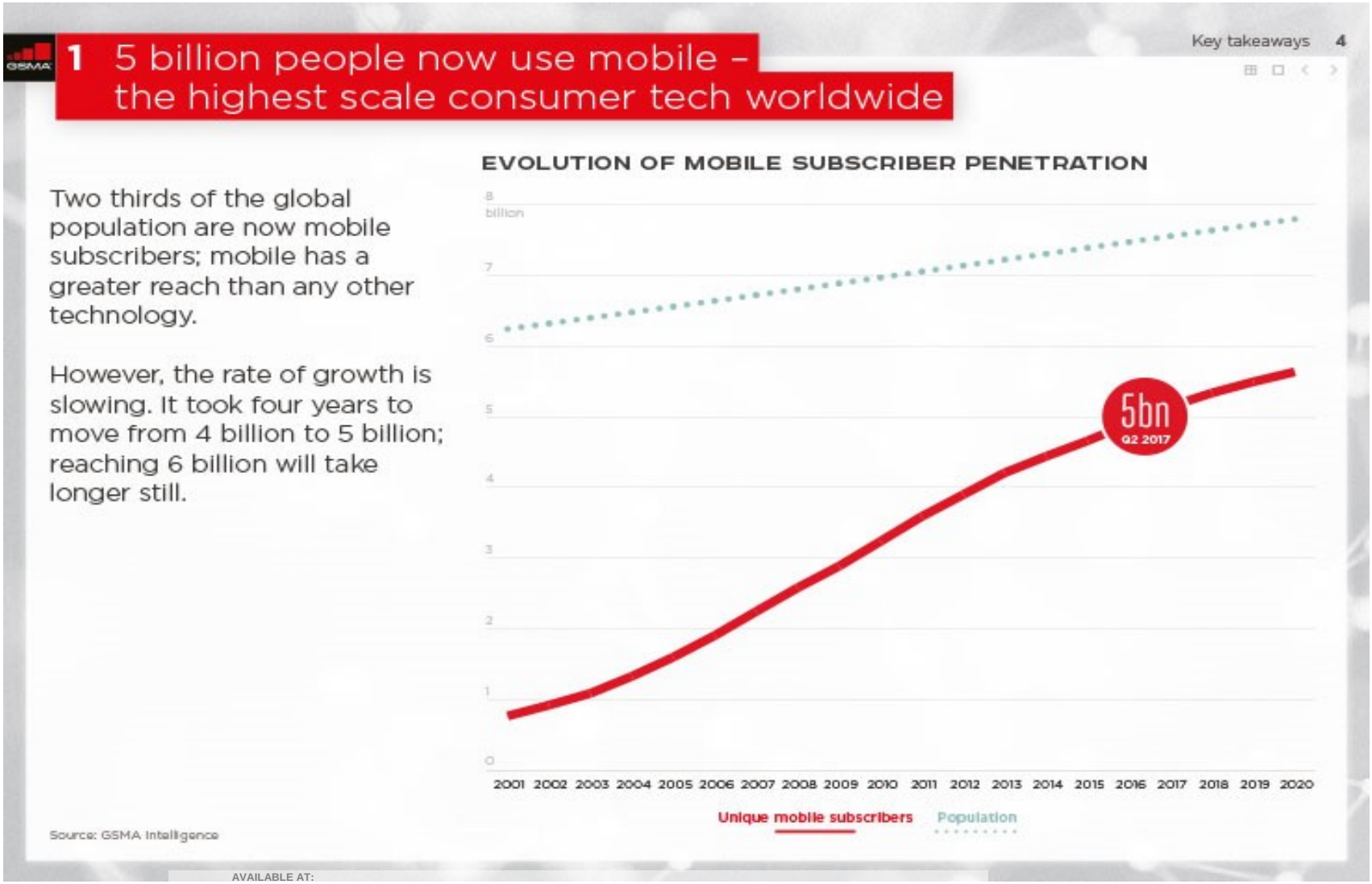
Example: Smartphone

- **Portability:** carry it anywhere you want
- **Miniaturization:** make it possible to build device to fit in your pocket
- **Connectivity:** Wi-Fi, LTE/4G, cellular, Bluetooth
- **Convergence:** phone, camera, gaming device, movie streaming, music player, …
- **Divergence:** ?
- **Applications:** “Rise of the Apps”
- **Digital Ecosystem:** social networks, distributed gaming, video streaming, work apps, …

App Store (iOS)

- 2003: iTunes Music Store
- 2008: iPhone App Store (iPhone 3G with App Store support)
- 2015: > 100 billion app downloads
- 2016: > 2 million apps
- 2016: China biggest App Store market
- 2016: App developers earned $20 billions
- Most downloaded app: Minecraft Pocket Edition (paid) and Pokemon GO (free)

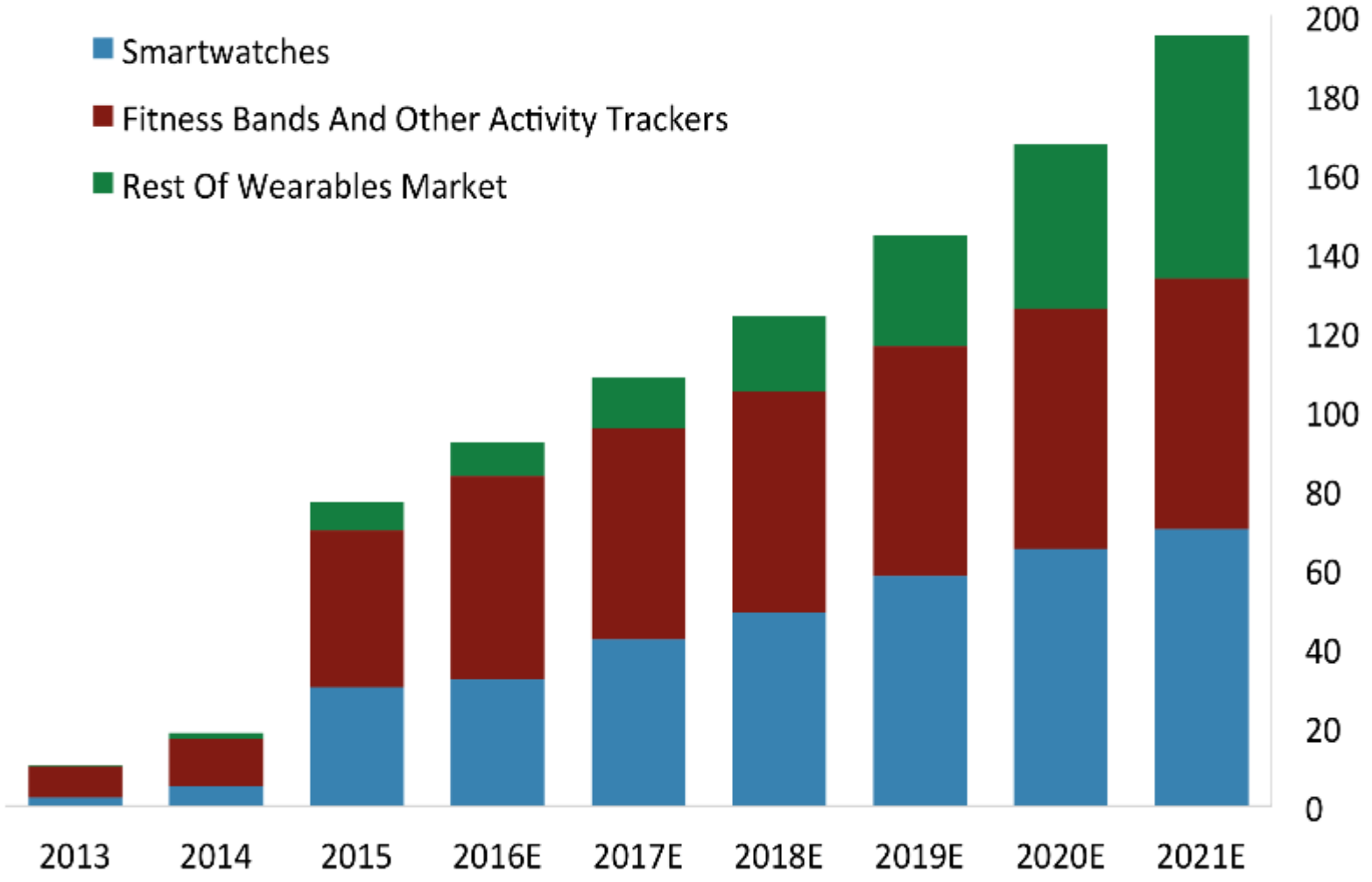
Trends in Mobile: Phone Subscribers



Trends in Mobile: Shopping

Global Wearables Shipment Forecast, By Device

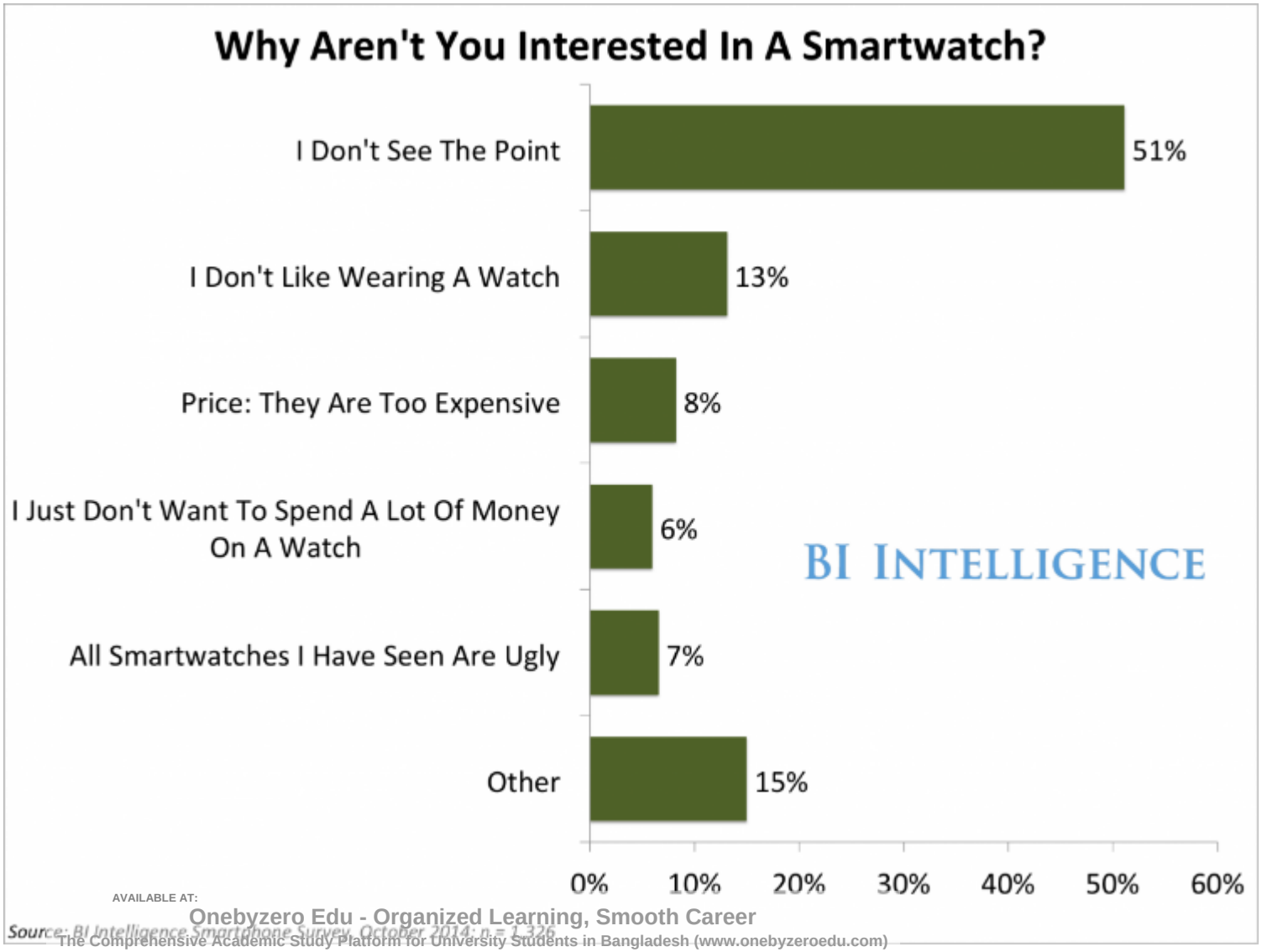
Millions



Source: IDC, BI Intelligence estimates

BI INTELLIGENCE

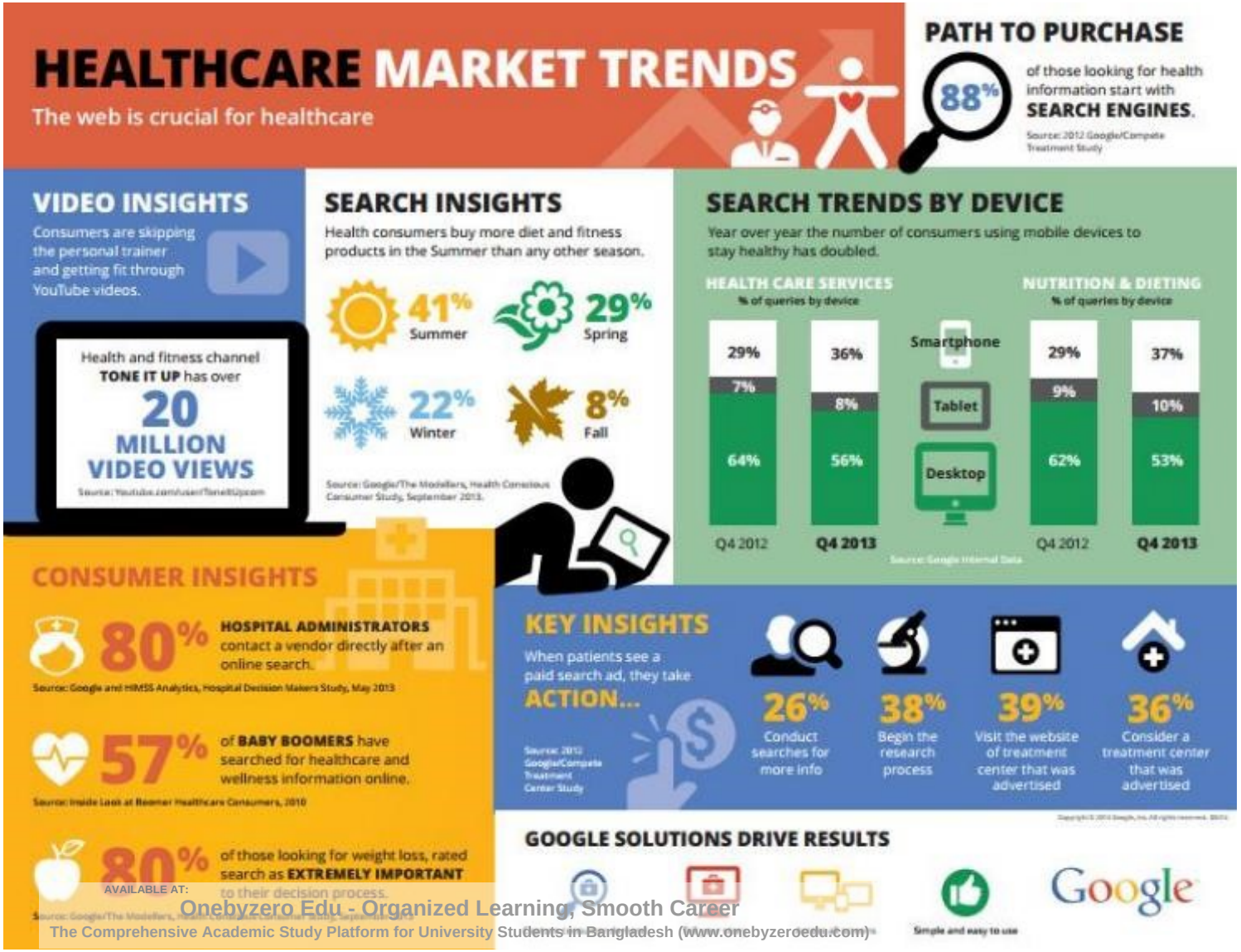
Trends in Mobile: Smart watches



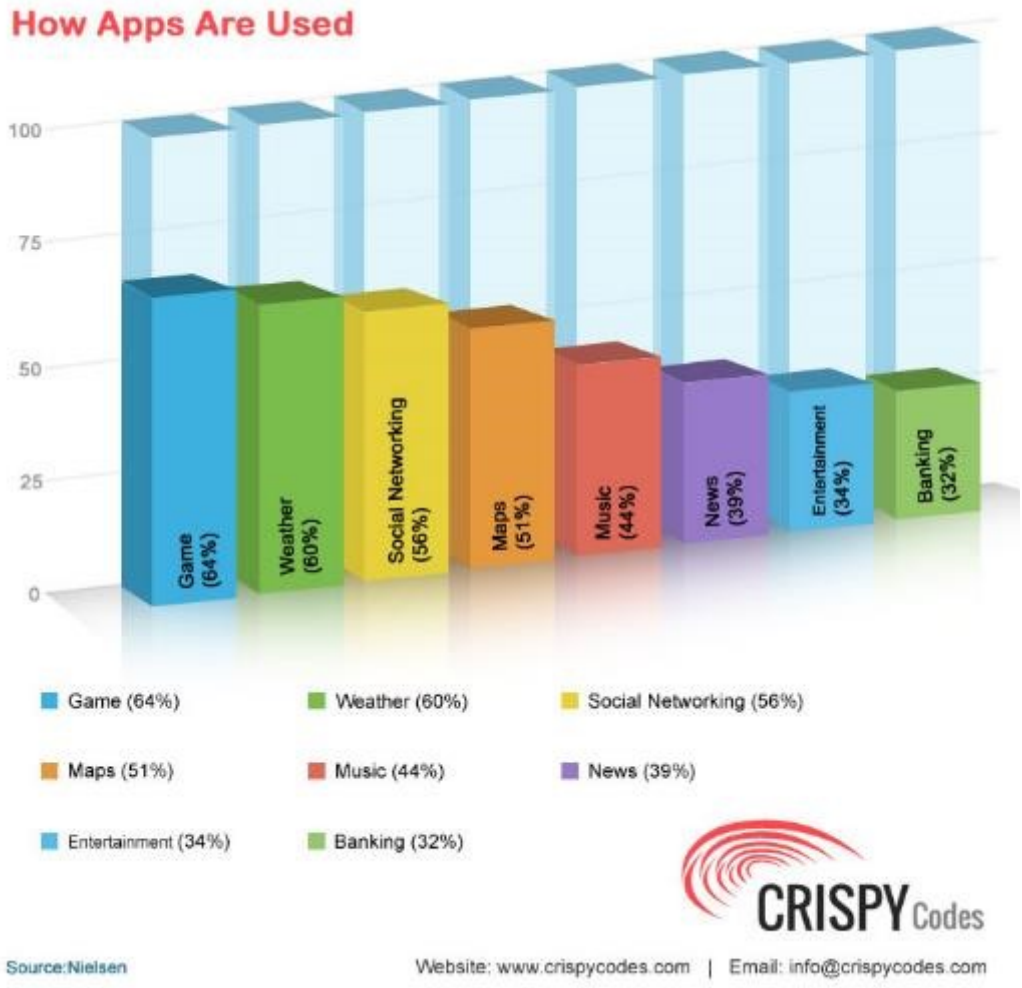
Smartwatch Market Size

Study Period:	2018 - 2026
Base Year:	2020
Fastest Growing Market:	Asia Pacific
Largest Market:	North America
CAGR:	14.5 %

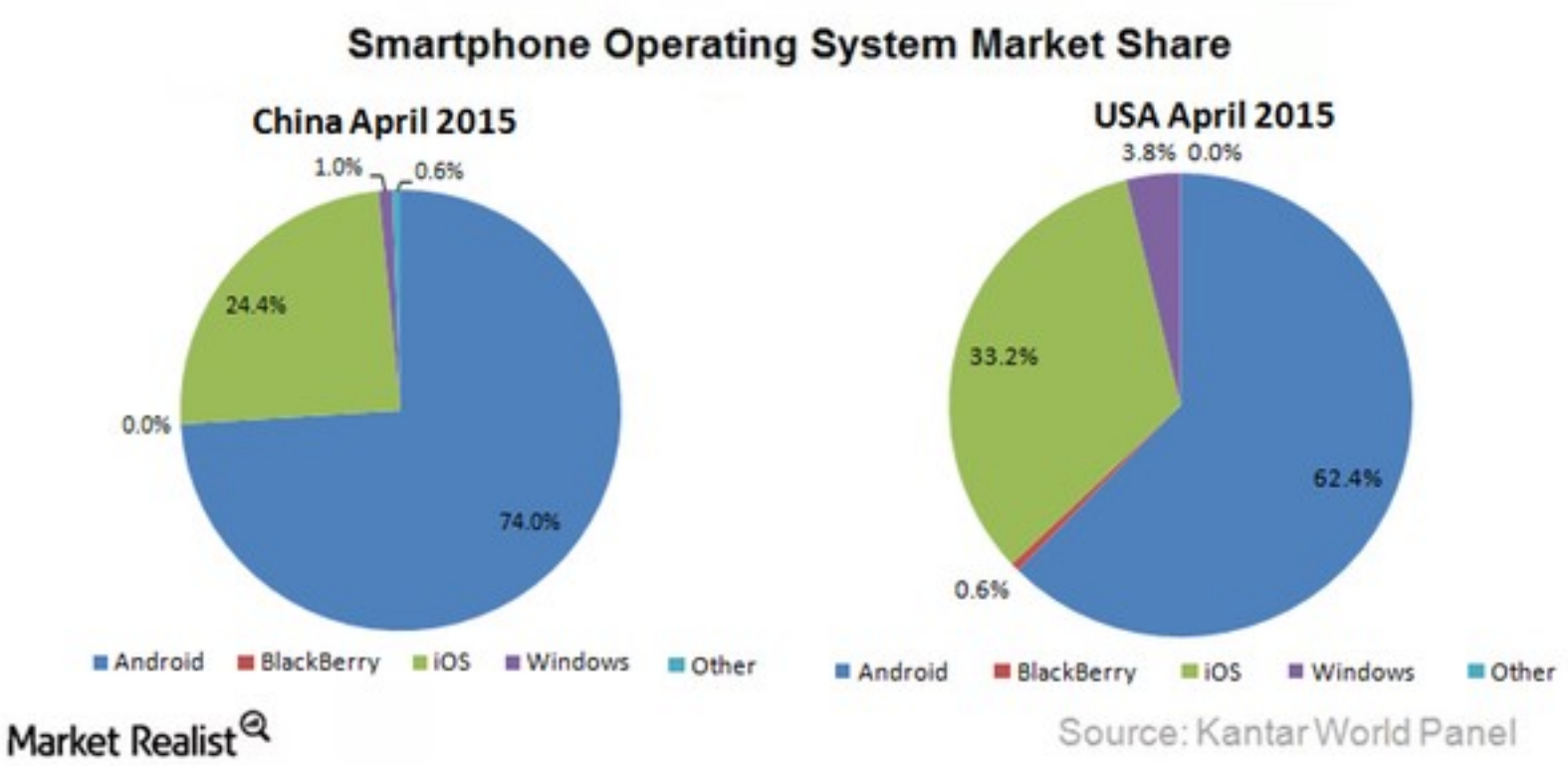
Trends in Mobile: Healthcare



Trends in Mobile: Apps



Trends in Mobile: Smartphone OS



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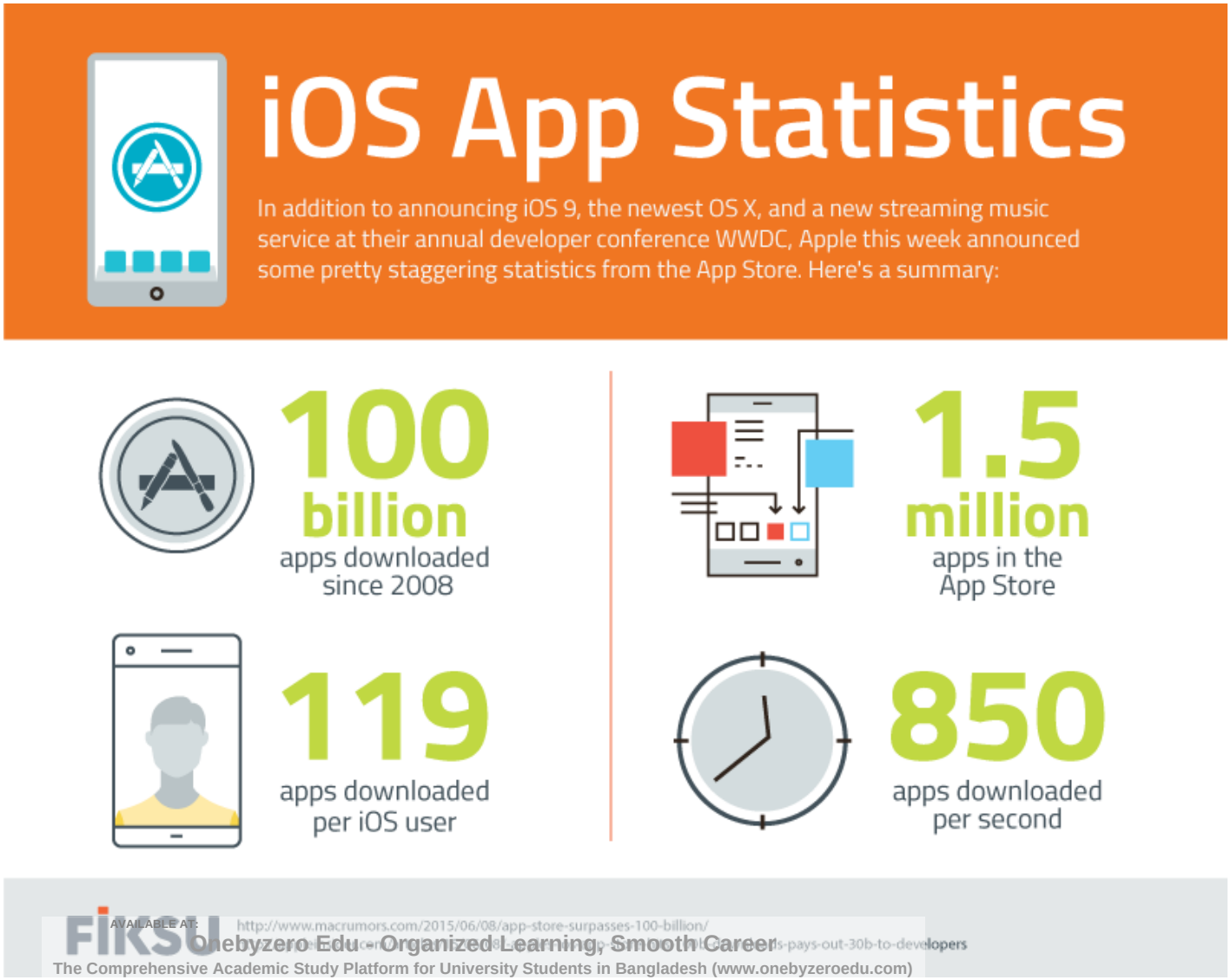
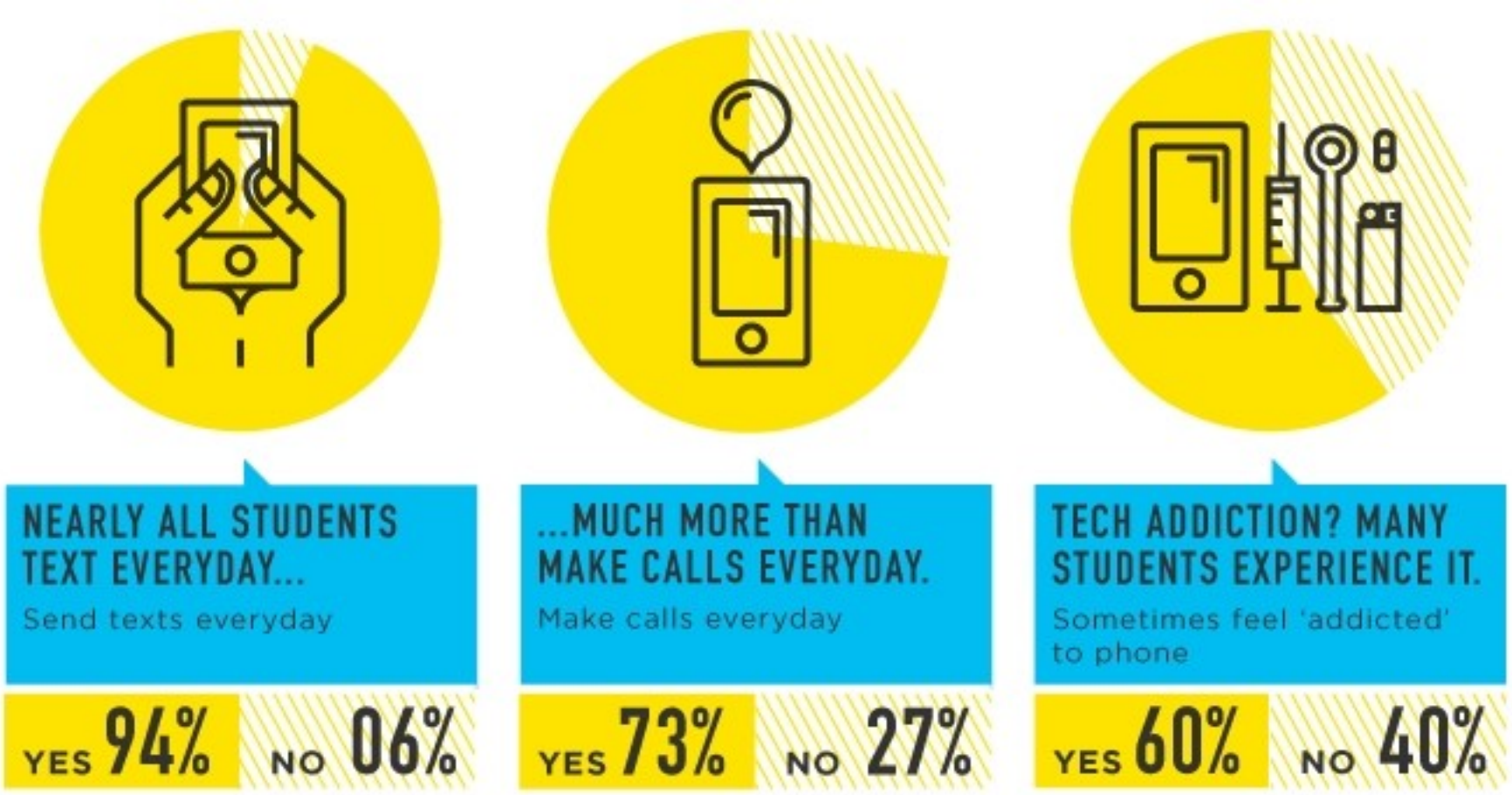


Trends in Mobile: Students



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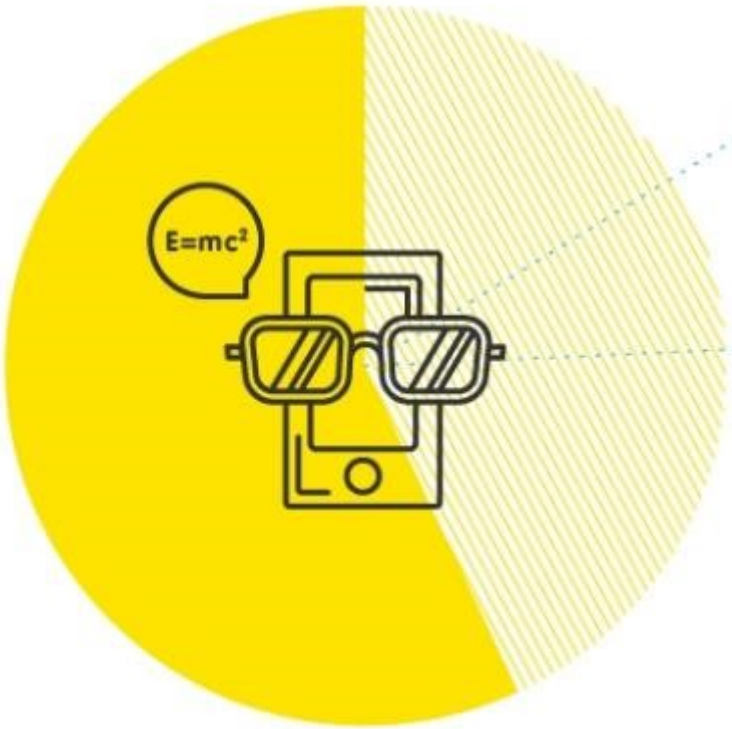

A MAJORITY OF STUDENTS IN OUR SURVEY USE SMARTPHONES.

SMARTPHONE: 57% BASIC: 43%

IPHONE AND ANDROID ARE NECK-AND-NECK FOR THE TOP SPOT

IPHONE	42%
ANDROID	43%
BLACKBERRY	12%
WINDOWS 7	02%

NEARLY ALL SMARTPHONE OWNERS USE THEM FOR SOCIAL NETWORKING...

Use phone for social networking

YES 97% NO 03%

BUT LUCKILY, CHEATING ON A PHONE IS RARE

Has cheated on test with phone

YES 13% NO 87%